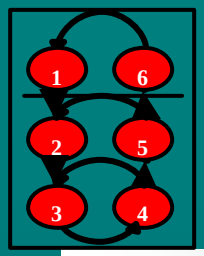
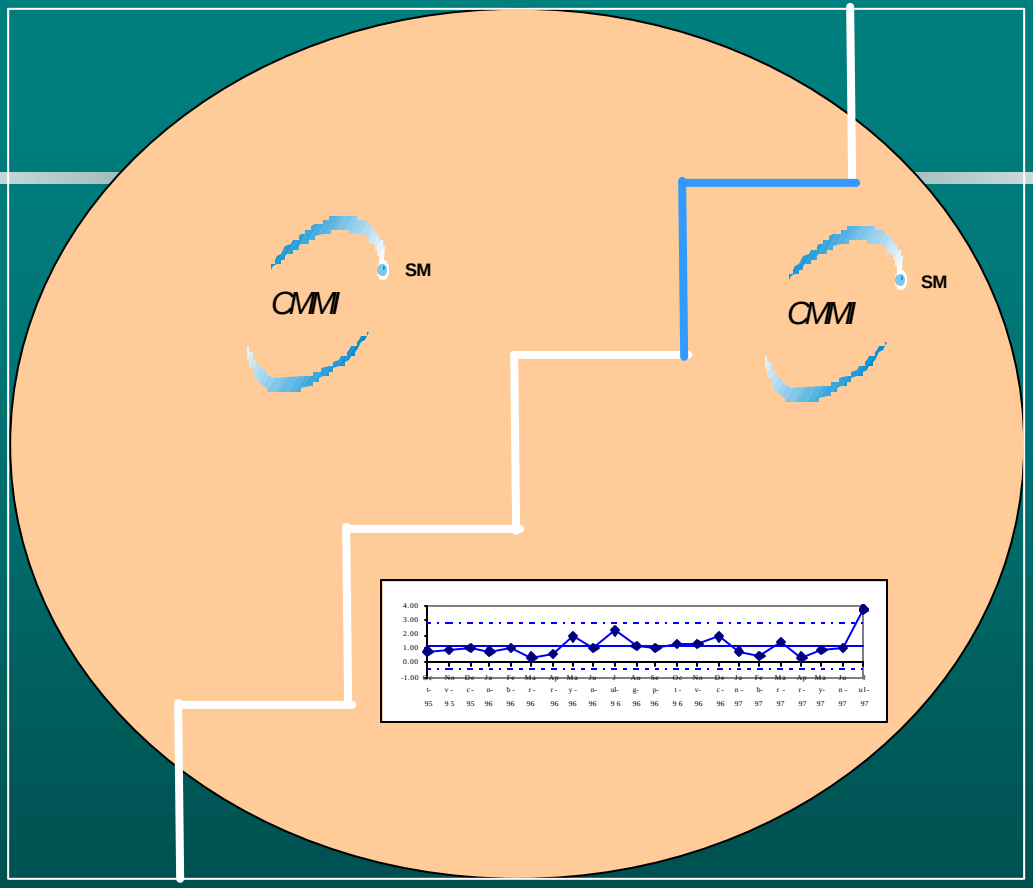




Portrait of a CMMI Level 4 Effort

Doug Smith & Craig Hollenbach

Litton/PRC

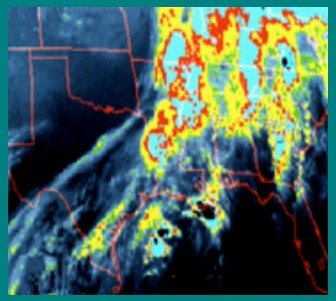
Litton PRC - A Leader in Systems Integration and Information Technology

- Headquarters in McLean, VA
- Over 80 offices worldwide
- ”Top 5“ systems integrator
- Subsidiary of Litton Industries
- 5500 employees

- SW-CMM L2: 12/95 (site)
- SW-CMM L3: 6/96 (sector), 6/99 (PRC)
- SW-CMM L5: 3/00 (PRC)
- ISO 9000/9001/9003 Registered

Sample PRC Systems Integration Programs

AWIPS



- Value: $350M
- Customer: DOC/NWS
- Open Systems development of satellite weather data sys
- Satellite station keeping, data download and distrib.
- COTS, GOTS & re-use

Development & Operation of Advanced Weather Information Processing Satellite Distribution System

ITN

- Value: $60M
- Customer: Dept of Justice
- Development of automated fingerprint ID Network
- 1,500 workstations and servers: 2M SLOC
- Open system

Identification, Tasking and Networking (ITN) will enable FBI to provide fingerprint ID nationwide

SSD

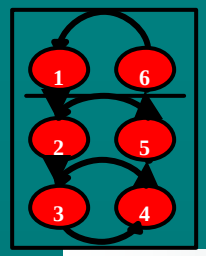
- Value: $120M
- Customer: AFMC/SSSG
- Sustaining Engineering, S/W Maint, & logistics support
- ITW/AA Sensors (BMEWS, PARCS, PAVE PAWS, GEODSS, Have Stare, etc)
- SEI 3 Team Capability

Sensor Support Division for mechanical & phased-array radars & optical sensors

JEDMICS

- Value: $200M
- Customer: DoD
- Document Imaging, Storage& MIS System
- 1994 Federal Mgmt Award
- >35 Systems installed

Joint Engineering Data Management Information Control System for engineering data repositories



The 6 Parts of CMMI Level 4

Organizational Process Performance (OPP)

Establish Quality and Process Performance Objectives and Measures (OPP SP1.1-1.3)

1

6

Establish Process Performance Baselines and Models (OPP SP1.4-1.5)

Organizational

Project

Quantitative Project Management (QPM)

Establish the Project's Objectives and Select Subprocesses to Measure (QPM SP1.1-1.3)

2

5

Manage Project Performance (QPM SP1.4)

Quantitative (QPM Goal 1)

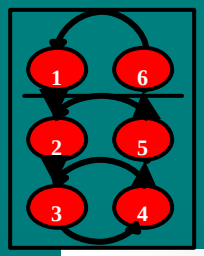
Statistical (QPM Goal 2)

Select Measures and Analytic Techniques (QPM SP2.1)

3

4

Monitor Performance of Selected Subprocesses (QPM SP2.2-2.4)



CMMI L4 Requirements

Organizational Process Performance (OPP)

SG 1 Establish Perf. Baselines & Models

- SP 1.1 Select Processes
- SP 1.2 Establish Process Performance Measures
- SP 1.3 Establish Quality and Process Performance Objectives

SG 1 Establish Perf. Baselines & Models

- SP 1.4 Establish Process Performance Baselines
- SP 1.5 Establish Process Performance Models

Quantitative Project Management (QPM)

SG 1 Quantitatively Manage the Project

- SP 1.1 Establish the Project's Objectives
- SP 1.2 Compose the Defined Process
- SP 1.3 Select the Subprocesses to be Managed

SG 1 Quantitatively Manage the Project

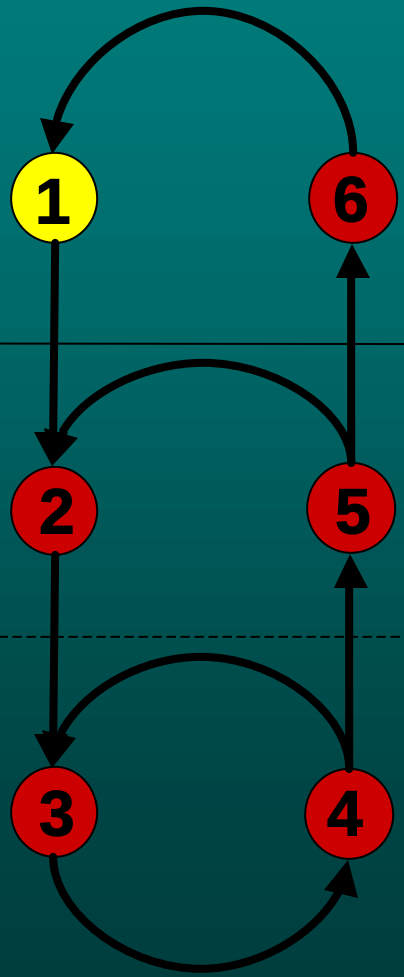
- SP 1.4 Manage Project Performance

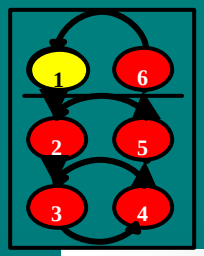
SG 2 Statistically Manage Subprocess Performance

- SP 2.1 Select Measures and Analytic Techniques

SG 2 Statistically Manage Subprocess Performance

- SP 2.2 Apply Statistical Methods to Understand Variation
- SP 2.3 Monitor Performance of the Selected Subprocesses
- SP 2.4 Record Statistical Management Data



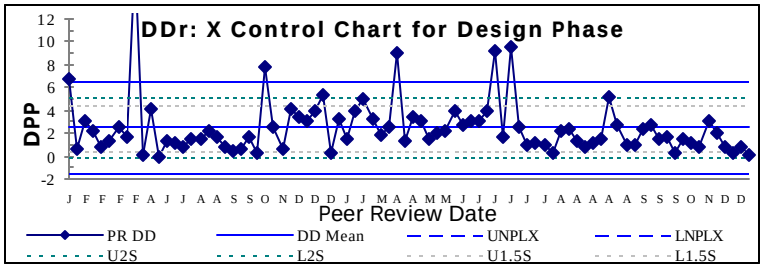


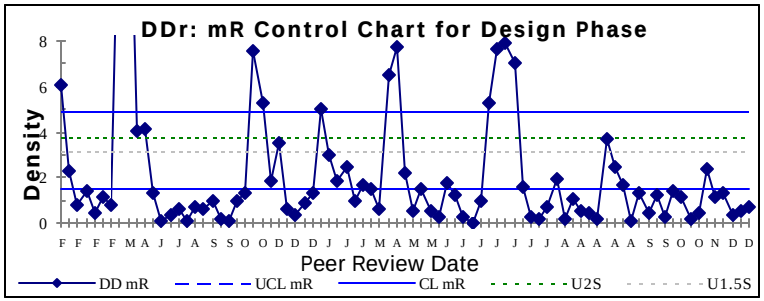
1. Establish Quality and Process Performance Objectives and Measures

- **CMMI Requirements**
  - OPP SP 1.1 Select Processes
  - OPP SP 1.2 Establish Process Performance Measures
  - OPP SP 1.3 Establish Quality and Process Performance Objectives
- **PRC Implementation:**

FY00 PRC Objectives	PRC Process Performance Objectives
3.1 Analyze customer satisfaction survey results. Introduce sector wide process change and standardization to improve product delivery and customer satisfaction.	1. Achieve Cost Performance Index (monthly) (CPIm) = 1 ± 0.1. 2. Achieve Schedule Performance Index (monthly (SPIm) = 1 ± 0.1. 3. Achieve ETC Performance Variance Percentage (monthly) (EPVPm) = 0 ± 0.1. 4. Achieve 10% improvement in DD specifications for each life cycle phase.

Defect Density (by review) Definition (ID: DDr)





Value Type and Characteristics

Type		Characteristics	
M	Measured (M) or Calculated (C)	Units:	Critical defects
C	Core (C) or Supplementary (S)	Range:	>= 0
	(L4 standard)	Goal:	<2 critical dpp
		Tolerance:	3 sigma

The definition of defects deemed “critical” is locally defined, usually in configuration management or software development plans, but is based on guidance from the Metrics Handbook. Generally, a critical defect prevents completion of the system mission, jeopardizes safety or security, has an adverse effect on essential capability with no work-around, or is a Peer Review “showstopper”.

Purpose/Goal

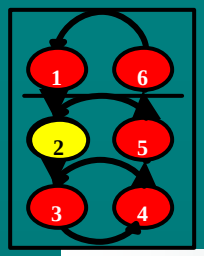
Defect Density (by review) (D
and indirectly, of review effec
the PRC Peer Review proces
Inspection process.
DDr is employed when the g

Definition

The general definition of DD
Defects are generally categor
calculated with just unique "c
often consists of comparing th
defects.

Product size is measured in physical pages or source lines of code (SLOC).

Acronym	Measurement	Process
CPIm	Cost Performance Index monthly	Earned Value System
DDb	Defect Density for CM Build from Test	Test
DDr	Defect Density from Peer Review	Peer Review
DDs	Defect Discovery from Test	Test
DDt	Defect Density from Test	Test
EPVPm	ETC Performance Variance Percentage monthly	Earned Value System or other financial process
SPIm	Schedule Performance Index monthly	Earned Value System



2. Establish the Project's Objectives and Select Subprocesses to Measure

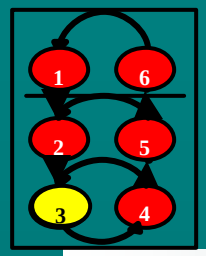
★ CMMI Requirements

- QPM SP 1.1 Establish the Project's Objectives
- QPM SP 1.2 Compose the Defined Process
- QPM SP 1.3 Select the Subprocesses to be Managed

★ PRC Implementation:

Projects tailor PRC plan and address project "points of pain"

Quantitative Management Objectives	
Project Performance	
Cost Cost Performance Index (CPI) Estimate to complete (ETC) performance (monthly) (EPVPm)	 Achieve CPI = 1 ± 0.1 Achieve EPVPm = 0 ± 0.1
Schedule Schedule Performance Index (SPI) SIT Schedule Performance Index SwIT Predicted End Date	 Achieve SPI = 1 ± 0.1 Achieve SPI = 1 ± 0.1 Predict end date ± 20% by 40% of planned
Product Quality	
Reliability (Releases to test) Defect Density (DDb)	 Achieve DDb = .001 ± .0005



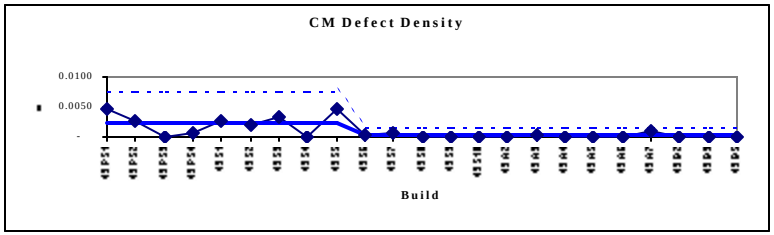
3. Select Measures and Analytic Techniques

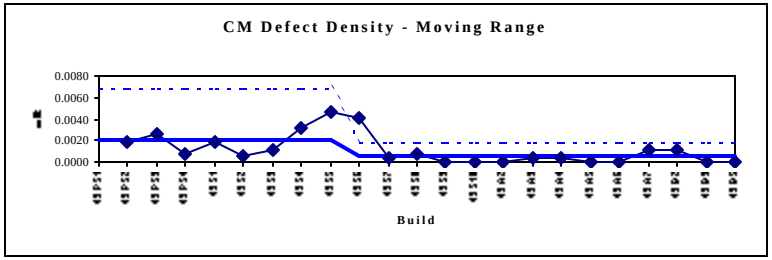
★ CMMI Requirements

- SP 2.1 Select Measures and Analytic Techniques

★ PRC Implementation:

Defect Density (by build) Definition (ID: DDb)





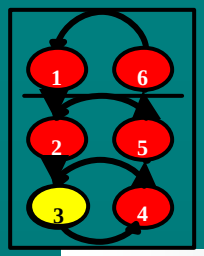
Value Type and Characteristics

Type		Characteristics	
M	Measured (M) or Calculated (C)	Units:	Critical defects
C	Core (C) or Supplementary (S)	Range:	>= 0
	(L4 standard)	Goal:	<2 critical dpp
		Tolerance:	3 sigma

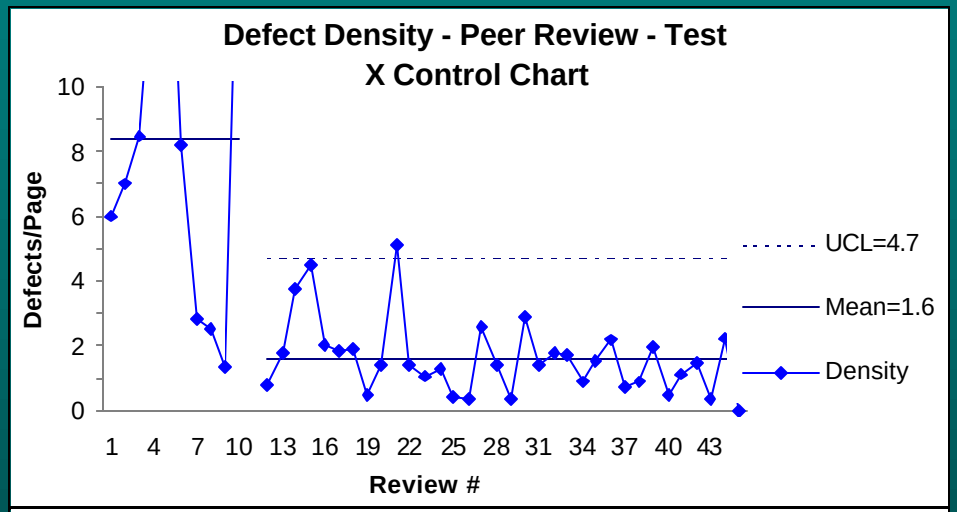
Interpretation

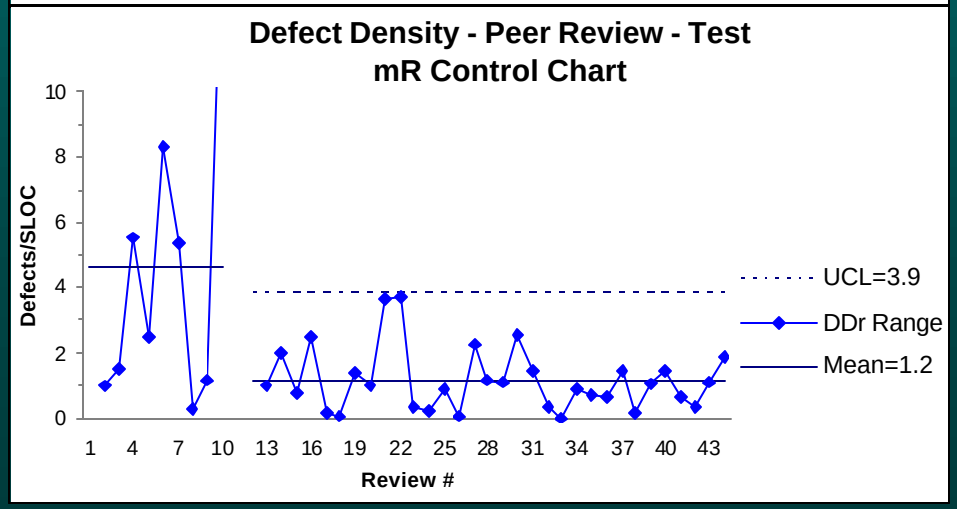
Purpose/Goal

Defect Density by build (DDb) is a primary (although indirect) indicator of product quality. Defects are inserted by building and releasing a portion of the product prior to testing and discovered by testers. DDb is generally

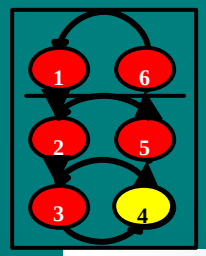


Statistical Process Control (SPC)



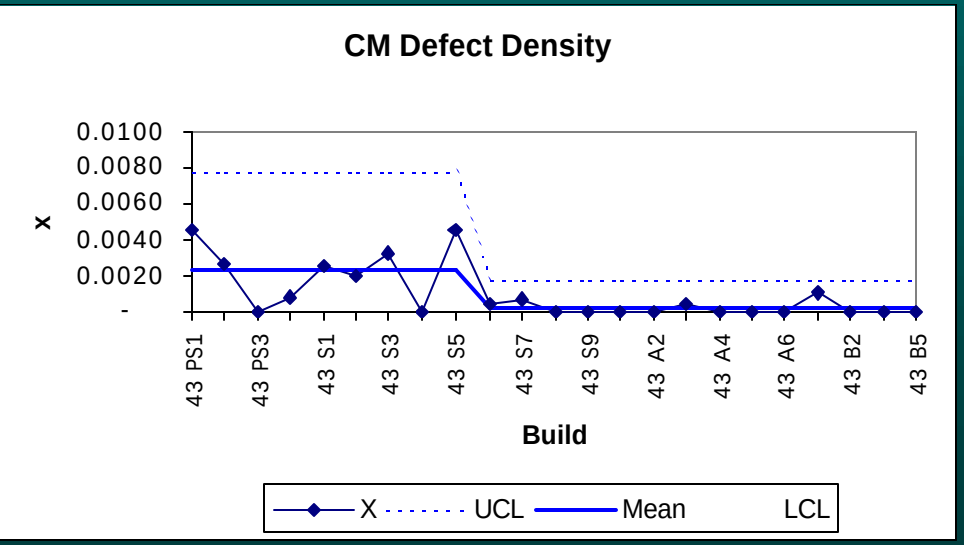


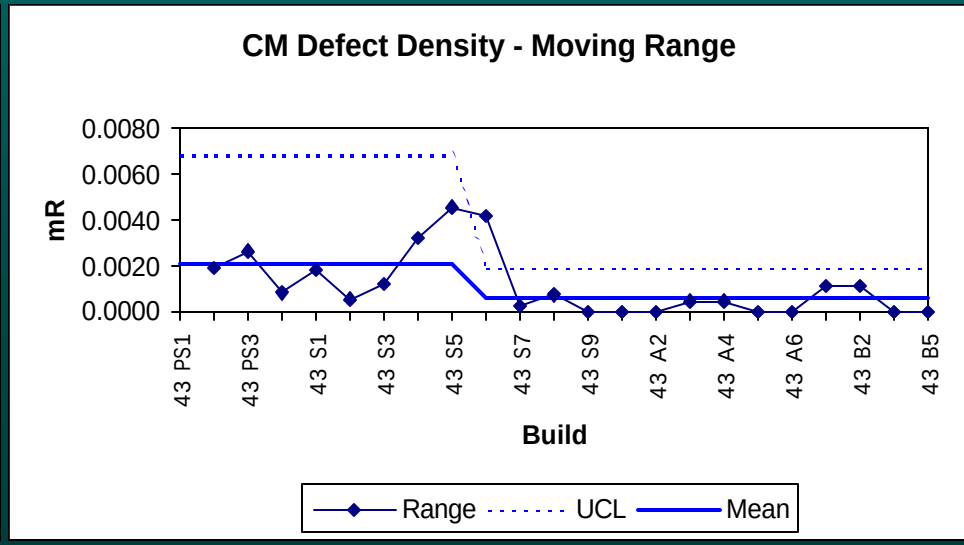
- ★ Most projects use XmR SPC charts to derive limits and analyze data
- ★ Some projects use X-bar-r charts & Rayleigh curve fits
- ★ Data plotted chronologically
- ★ Limits based on variability within data set; reset when process changes
- ★ Used 6 rules for determining special causes of variation

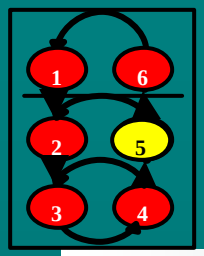


4. Monitor Performance of Selected Subprocesses

- **CMMI Requirements**
  - SP 2.2 Apply Statistical Methods to Understand Variation
  - SP 2.3 Monitor Performance of the Selected Subprocesses
  - SP 2.4 Record Statistical Management Data
- **PRC Implementation:** Project Control Chart - DDb







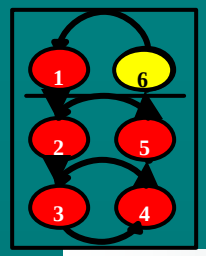
5. Manage Project Performance

- **CMMI Requirements**
  - SP 1.4 Manage Project Performance
- **PRC Implementation:**
  - Monitor project "points of pain"
  - PPBL by life cycle phases

Quantitative Management Objectives	
Project Performance	
Cost	
Cost Performance Index (CPI)	Achieve CPI = 1 ± 0.1
Estimate to complete (ETC) performance (monthly) (EPVPm)	Achieve EPVPm = 0 ± 0.1
Schedule	
Schedule Performance Index (SPI)	Achieve SPI = 1 ± 0.1 Achieve SPI = 1 ± 0.1
Product Quality	
Quality	
Defect Density – Peer Review (DDr)	Achieve DDr = .02 ± .002
Defect Density – Test (DDt)	Achieve DDt = .0005 ± .00005

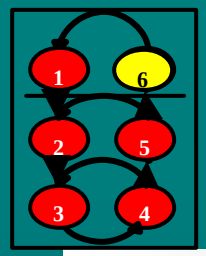
Project Process Performance Baseline

Life Cycle Phase	Project's Measured Process ID	Measure	Specification from Project QM Plan	Mean	UCL	LCL	Units	Project's Collecting Process ID
Analysis	PEM100	DDr	.02 ± .002	1.0170	3.6765	-1.6426	Pages	PR100
Pdesign	PEM200	DDr	.02 ± .002	0.3518	1.0944	-0.3908	Pages	PR100
Cdesign	PEM300	DDr	.02 ± .002	0.3837	1.6263	-0.8588	Pages	PR100
Code	PEM400	DDt	.0005 ± .00005	3.8824	17.2873	-9.5225	KSLOC	PR200
Test	PEM500	DDr	.0005 ± .00005	0.3168	1.1674	-0.5339	Pages	PR100
Test	PEM500	DDt	.0005 ± .00005	0.0604	0.3247	-0.2040	Req't	PEM500
Ops	PEM600	DDt	.0005 ± .00005	0.0729	0.2960	-0.1502	Req't	PEM600
Ops	PEM700	DDt	.0005 ± .00005	0.0526	0.2970	-0.1918	Req't	PEM700



6. Establish Process Performance Baselines and Models

- **CMMI Requirements**
  - SP 1.4 Establish Process Performance Baselines
  - SP 1.5 Establish Process Performance Models
- **PRC Implementation:**
  - Organizational Process Performance Baseline
  - Defect Density by Life Cycle Phase model
  - Rayleigh Defect Detection model

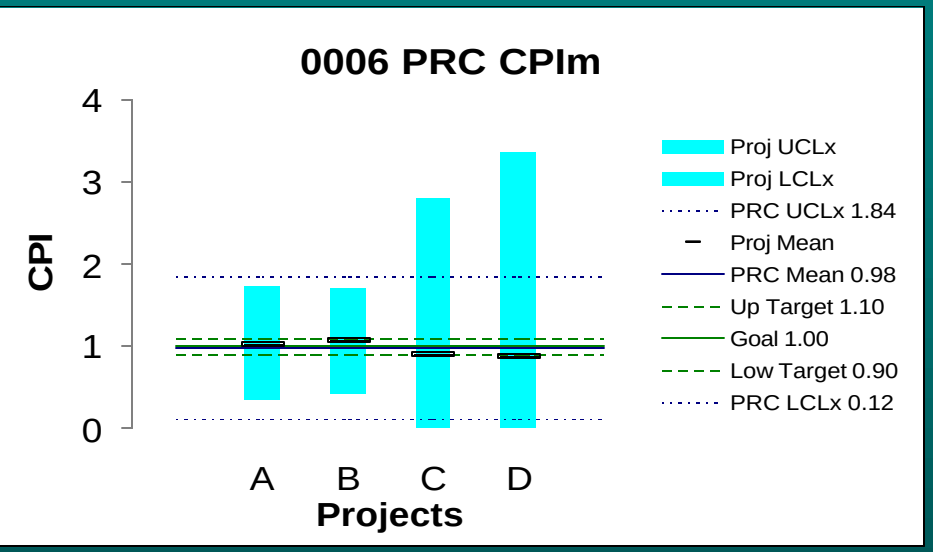


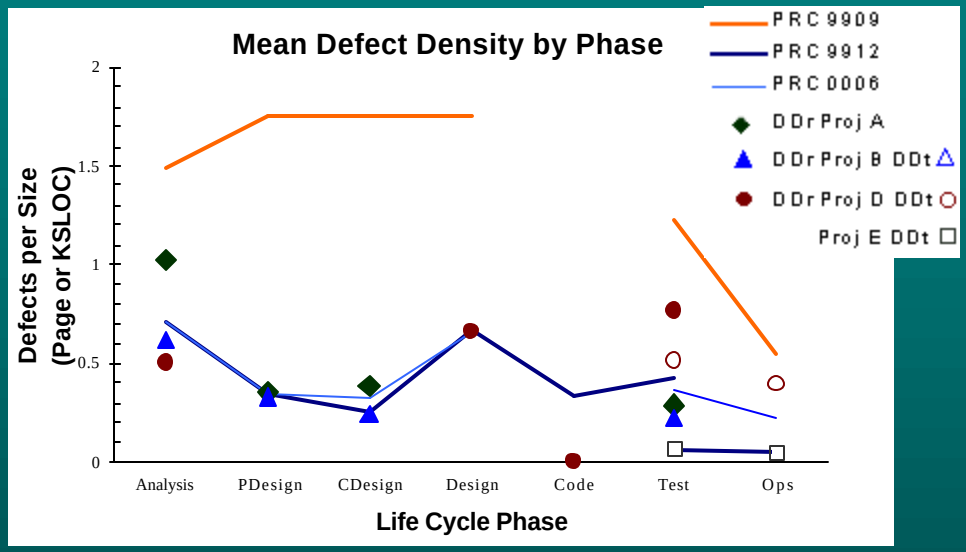
Organizational Performance Baseline

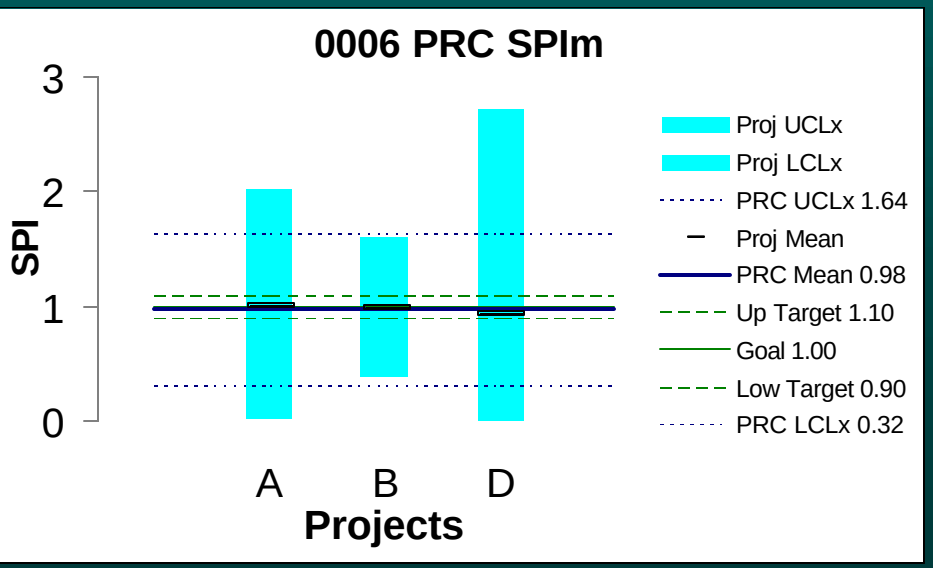
Product Quality						Baseline 2.2			Baseline 2.0			Change	
Phase	Measured Process		Measure	Units	Spec	Mean	UCL	LCL	Mean	UCL	LCL	Mean	CL
Analysis	PE2310	Software Requirements Analysis	DDr	Pages	0.780	0.710	3.369	0	0.709			0%	
PDesign	PE3110	Preliminary Software Design	DDr	Pages	0.375	0.341	3.000	0	0.341			0%	
CDesign	PE3210	Detailed Software Design	DDr	Pages	**0.287**	0.316	2.975	0	0.261	1.314	0.000	21%	-158%
Design	PE3110, PE3210	Preliminary Software Design, Detailed Software Design	DDr	Pages	0.739	0.655	2.599	0	0.672	2.532	0.000	-2%	-4%
Code	PE4110	CSU Code	DDr	SLOC	**0.004**	0.005	1.187	0	0.004			47%	
			DDt	KSLOC	6.930	3.204	14.885	0	6.300			-49%	
			DDt	Reqts	4.047	3.882	17.287	0	3.679			6%	
Test	PE5110, PE5210, PE5300	CSC Integration and Test, CSCI Integration and Test, System Integration and Test	DDr	Pages	0.379	0.356	1.783	0	0.421			15%	
	PE000	Product Engineering Macro	DDt	KSLOC	**0.060**	0.362	2.316	0	0.067			-443%	
			DDt	Reqts	0.125	0.059	1.687	0	0.139			57%	
	PE5110, PE5210, PE5300	CSC Integration and Test, CSCI Integration and Test, System Integration and Test	DDb	Files	**0.0002**	0.0002	0.002	0	0.0002	0.002	0.000	0%	0%
Ops	PE000	Product Engineering Macro	DDt	KSLOC	**0.047**	0.218	2.877	0	0.053	0.297	0.000	-315%	-1056%
			DDt	Reqts	**0.036**	0.048	2.707	0	0.040	0.233	0.000	-19%	-1287%
Non-LC	PE4110	CSU Code	DDr	Pages	0.960	0.484	1.466	0	1.067	3.078	0.000	55%	80%
Phase	Measured Process		Measure	Units	Spec	Mean	Max	Min	Mean	Max	Min	Mean	Max
Test	PE5110, PE5210, PE5300	CSC Integration and Test, CSCI Integration and Test, System Integration and Test	DDs	% defects	**2.0**	1.177	5.525	-0.354	1.177	5.525	-0.354	0%	0%

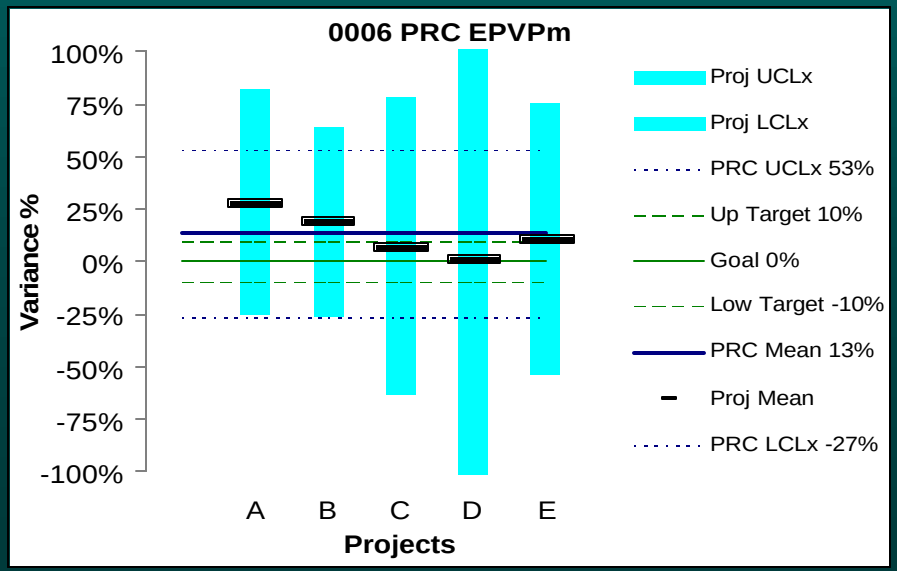
Process Performance													
Phase	Measured Process		Measure	Units	Spec	Mean	UCL	LCL	Mean	UCL	LCL	Mean	CL
	PP000, PT000	Project Planning, Project Tracking & Oversight	EPVPm		0 ± .1	0.133	0.532	-0.266	0.105	0.482	-0.272	-27%	-13%
			CPIm		**1 ± .1**	0.977	1.840	0.115	1.147	1.515	0.779	-15%	-88%
			SPIm		**1 ± .1**	0.980	1.641	0.319	1.004	1.272	0.736	-2%	-138%

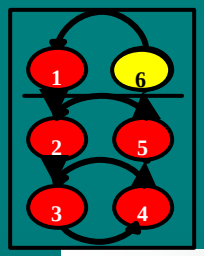
Organizational Baseline Analysis



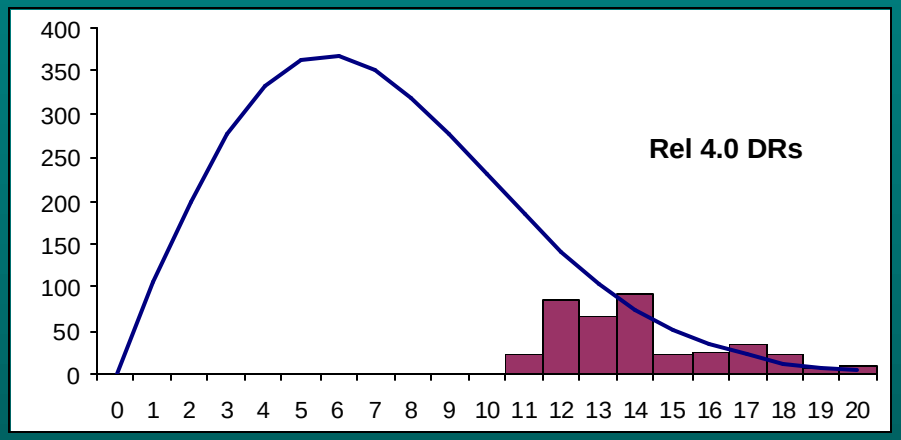


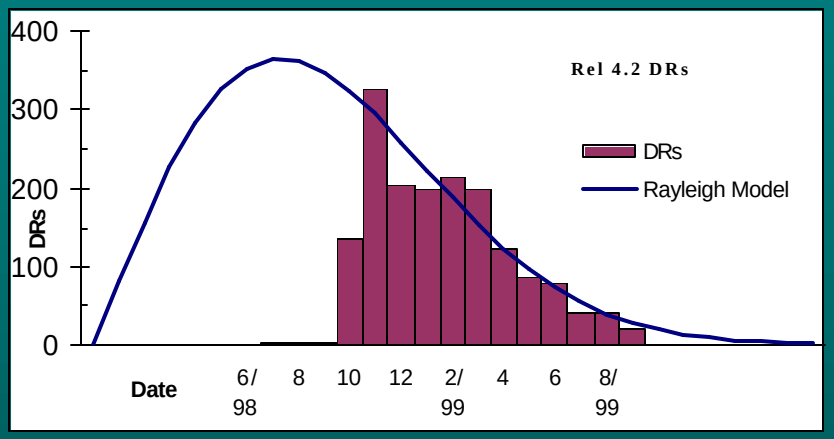


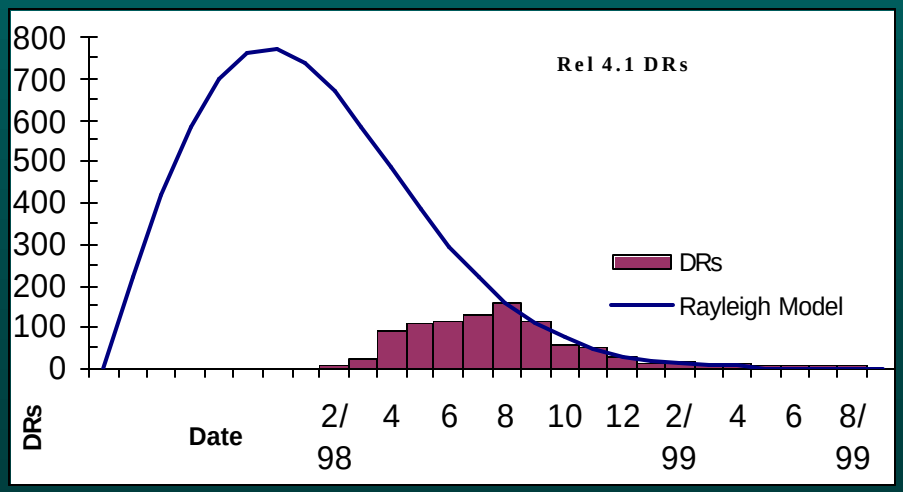


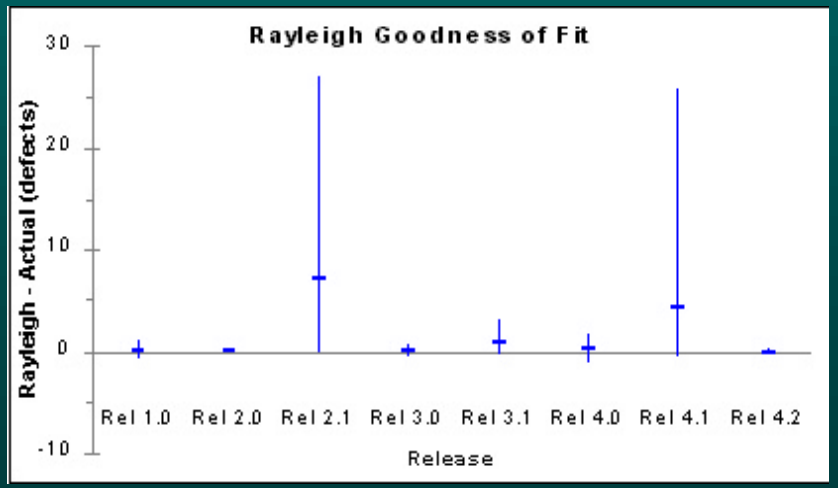


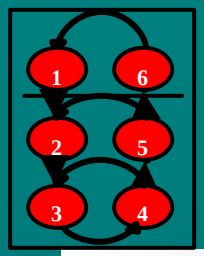
Rayleigh Curves











PRC L4 CMMI Experience

- Statistical methods can be applied to a variety of process area ‘subprocesses.’
- Statistical analysis provides direct and substantial benefit to projects.
- Organizational business goals and project ‘points of pain’ best determine which process areas and subprocesses to bring under quantitative and statistical control.
- Statistical analysis can be performed by less mature projects.
- Data analysis is challenging for organizations with different project environments.